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TITLE: CARBON NANOTUBE DEVICE

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REFERENCE-FIGURES: 2

ABSTRACT:

Transistor, is disclosed, including a base having a bundle of (n,n) nanotubes, and an emitter and a collector connected to opposite sides of the base each having (n, m, n-m.noteq.3l) nanotubes, whereby substantially reducing a device



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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2002/0098135 A1**  
Smalley et al. (43) **Pub. Date: Jul. 25, 2002**(54) **ARRAY OF SINGLE-WALL CARBON  
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Main Street, Houston, TX 77005 (US)(21) **Appl. No.:** 10/033,050(22) **Filed:** Dec. 28, 2001**Related U.S. Application Data**(62) Division of application No. 09/380,545, filed on Dec.  
22, 1999, which is a 371 of international application  
No. PCT/US98/04513, filed on Mar. 6, 1998.(30) **Foreign Application Priority Data**Mar. 7, 1997 (US)..... 60040152  
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May 29, 1997 (US)..... 60047854**Publication Classification**(51) **Int. Cl.<sup>7</sup>** ..... B01J 8/06; B01L 7/00  
(52) **U.S. Cl.** ..... 422/198; 423/447.2; 422/190;  
422/211; 422/222(57) **ABSTRACT**This invention relates generally to forming an array of  
single-wall carbon nanotubes (SWNT). In one embodiment,  
a macroscopic molecular array is provided comprising at  
least about  $10^6$  single-wall carbon nanotubes in generally  
parallel orientation and having substantially similar lengths  
in the range of from about 5 to about 500 nanometers.



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(43) Pub. Date: **Apr. 25, 2002**(54) **CATALYST-INDUCED GROWTH OF CARBON NANOTUBES ON TIPS OF CANTILEVERS AND NANOWIRES****Publication Classification**(51) Int. Cl.<sup>7</sup> ..... **C25D 5/18; C25D 7/12; B32B 9/04**(52) U.S. Cl. .... **205/104; 205/192; 428/411.1; 205/157; 428/446**(76) Inventors: **James Welfu Lee**, Oak Ridge, TN (US); **Douglas H. Lowndes**, Knoxville, TN (US); **Vladimir I. Merkulov**, Knoxville, TN (US); **Gyula Eres**, Knoxville, TN (US); **Yayi Wei**, Fishkill, NY (US); **Ellas Greenbaum**, Oak Ridge, TN (US); **Ida Lee**, Oak Ridge, TN (US)

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(21) Appl. No.: **09/873,928**(22) Filed: **Jun. 4, 2001****Related U.S. Application Data**

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(57) **ABSTRACT**

A method is described for catalyst-induced growth of carbon nanotubes, nanofibers, and other nanostructures on the tips of nanowires, cantilevers, conductive micro/nanometer structures, wafers and the like. The method can be used for production of carbon nanotube-anchored cantilevers that can significantly improve the performance of scanning probe microscopy (AFM, EFM etc). The invention can also be used in many other processes of micro and/or nanofabrication with carbon nanotubes/fibers. Key elements of this invention include: (1) Proper selection of a metal catalyst and programmable pulsed electrolytic deposition of the desired specific catalyst precisely at the tip of a substrate, (2) Catalyst-induced growth of carbon nanotubes/fibers at the catalyst-deposited tips, (3) Control of carbon nanotube/fiber growth pattern by manipulation of tip shape and growth conditions, and (4) Automation for mass production.

